Some Technical, Legal, and Political Impediments to Developing Water Resources in the Middle East

Earth-Generated Water: A Potential Solution

"Waters divided. . . "[1] *or "well[s] of living waters" and "living fountains of waters"?*[2]

Morad Eghbal*

The Middle East is not the only place where water crises and disputes arise and continue, but it is the region in which the potential for conflict over water is perhaps most extreme. A long history of hostilities and border disputes, plus the presence of oil, make the need for binding international agreement most pressing, though history gives us little confidence that international law can avert wars there. Though the region is generally referred to as a whole—the Middle East—it is full of contradictory values, ranging from those of the desert, shaped predominantly by nomads, to the ideas of shepherds of the plains, and to the expectations of farmers and urban population of the few areas rich in water resources. These regional and local rules, no matter how contemporary they might seem, were founded on values that grew out of religious and social customs—often more rigid than the harshest of state-made laws.

We will embark on a journey in three parts. Part One, about our "water planet," sets the stage for water use, water rights, and regional security in the Middle East. Part Two briefly surveys the paradigm-breaking scientific work of Stephan Riess, with its relevance to providing much-needed additional supplies of potable fresh water, particularly in the Middle East. One hopes this new paradigm could guide present dialogue in a different and long-ignored direction. Perhaps this could further the evolution of more cooperative, less adversarial approaches. In Part Three we will address the interface between water resources and water rights in the Middle East, considering two river systems of particular interest: the Euphrates and Tigris river system and the Jordan Valley.

If so much of the Earth's surface is covered with water, why are so many areas of the world, especially the Middle East, experiencing shortages and competing for fresh water?

The Water Planet

Every living thing on this unique planet has a water connection. Our bodies are approximately 60% water, which lubricates our internal systems, keeps them free from waste, and maintains normal body temperature. Beyond these confines, trees, which are considered the "lungs" of the Earth, are 70% water and rely for the most part on a steady and reliable supply of fresh water. Every living cell is water-dependent and therefore vitally affected by the quality and quantity of fresh water available.

One of the circulatory systems which provides this vital resource is known as the *hydrologic cycle*, which is both simple to describe and complex in its application. Circulatory means recycling, a word that has increasingly permeated the consciousness of the public. In nature, recycling is a built-in part of the ecosystem and is the way water in changing form and function is used and re-used. Water descends upon the face of the Earth as precipitation of one kind or another. It penetrates the surface and migrates along aquifers, a word whose Latin origin connotes the leading of water collected along a particular stratum, toward a point where it will resurface once again, to run off in creeks, streams, and rivers—ultimately collecting in the lowest points, from where it again rises by evaporating and condensing into clouds, to descend again as precipitation.

This evapo-transpiration system is run by the energy of the Sun, which causes liquid water to turn into vapor, a change which is under way constantly over all bodies of water and on wet surfaces. We could say that we live in a state of constant net-deficit of this vital resource. Forests act as natural water reservoirs and are an important part of the Earth's hydrological system. The leaves and branches of trees catch a great amount of rainfall that would otherwise run off into streams. They shed this moisture on the surface of the ground, some of it to be held in the thick layer of duff that forms the mulch covering forest floors. Trees and plants also absorb water through their root systems. The moisture that is not used up by trees or plants rises through osmotic pressure and evaporates to the atmosphere. Remarkably, water from the hydrologic cycle is *not the only* source of fresh water, as we shall see!

If so much of the Earth's surface is covered with water, why are so many areas of the world, especially the Middle East, experiencing shortages and competing for fresh water? It is simply that fresh water resources, at least obviously accessible ones, are not evenly distributed either within national boundaries or globally.

The planet's rapidly expanding human population also places a severe strain on the supply of this vital resource. This is not so much because supplies are low in an absolute sense, but because an ever-increasing population places ever larger demands on locally available reliable sources of fresh water.

As a result of this population increase, every country today is not only confronted with a growing demand for water, it must also come to terms with accompanying legal problems. If we add the additional concern of increased levels of industrialization, one can readily see how complicated the equation becomes and why non-industrialized countries also have the highest demand for this resource. They lack technological advance, being dependent mainly on agriculture, perhaps the most water-intensive industry in the world.

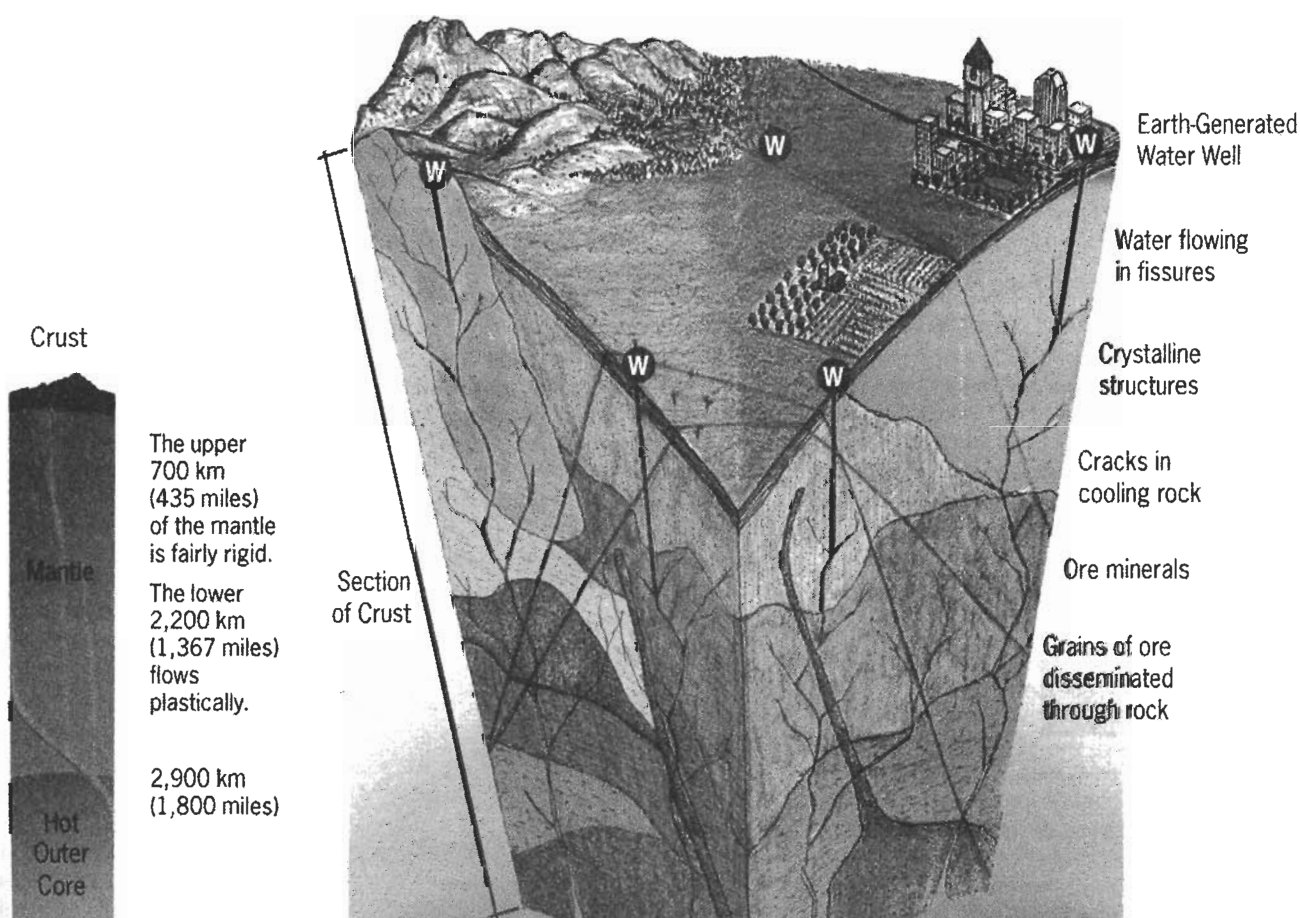
Earth-Generated Water

Turning now to the second part of our journey, we discover possible alternatives to these persistent problems. For at least twenty-five years a global water shortage has been the focus of increasingly dire predictions in the national and world press.[3] First, there is over-pumping of groundwater from fairly shallow aquifers—for example, the Ogallalla that underlies the High Plains states in the United States from the Dakotas to the Texas Panhandle. Replenishment of this water by precipitation has not kept pace with an over-greedy use of this water. Should the tapping of such aquifers continue at present rates, the question arises whether that portion of the High Plains overlying the Ogallalla Aquifer will once again become the "Great American Desert." It was so labeled on maps in the middle of the past century, long before the water below it was used for irrigation.

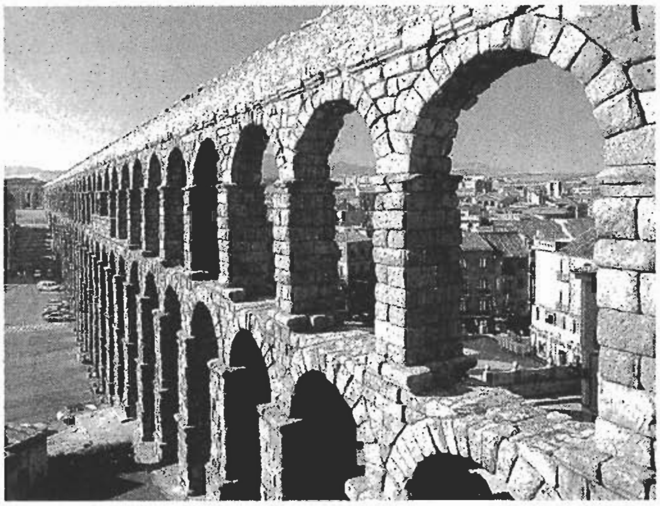
Then there is the increasing pollution of groundwater sources in many areas due to the influx of chemicals and toxins. Typical is the nine million gallons of chemicals that have poured into Price's Pit, the municipal dump at Atlantic City, New Jersey, which caused water in ten of fourteen city wells to become unpotable in the early 1980s.[4]

The solutions to this problem advanced by policy-makers are basically of two kinds.[5] Solution one: Building very expensive "long-distance plumbing" in the form of pipelines, canals, and other conduits to channel water from rivers or from impoundments behind dams. This approach has been in favor since the days of the Babylonian King Hammurabi, who built an extensive system of irrigation canals in his Near Eastern domain. It

Source of Earth-Generated Water



Courtesy of The Riess Institute



Roman Aqueduct, Segovia, Spain *Photo by Barbara DelloRusso*

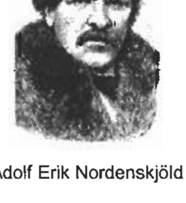
also flourished in the vast network of aqueducts that were constructed throughout the Roman empire.

The second solution: Conserve existing supplies through voluntary limitation of use, *i.e.* rationing, or perhaps more effectively, through a steep rise in the price of water. Neither the "conservationists" nor the "long-distance plumbing advocates" seem to be aware of a third solution to water shortage problems. With the exception of a few stalwarts who have advocated its potential for more than a century, this solution has remained dormant, thanks to outworn dogma.

Dogma insists that all the water available to humankind derives exclusively from the hydrologic cycle, which we have described above. Even as recent a publication as "Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan" by the National Science Foundation[6] overlooked this potentially highly promising alternative. Advocates take exception to the well-entrenched notion that the Earth's water can *only* be of "meteoric" origin. (Editor's Note: The author means weather-borne water, not extraterrestrial water—as in the controversy over the influx of "small comets."—EFM) They have affirmed that the Earth itself generates massive amounts of water from deep within, which has no connection with the water of the hydrologic cycle. They maintain that if this water were to be tapped by drilling, it would constitute a copious—for all intents and purposes an inexhaustible—supply of pure, unpolluted water.

Leonardo da Vinci, in his famous *Treatise on Water*, championed the idea that water comes *both* from precipitation *and* from internally generated sources. In his *History of Hydrology*, Asit K. Biswas notes that the Renaissance genius

> characteristically reported an occasional doubt about certain aspects of both theories, but nothing has been found which would indicate that he at any time had discarded the basic concepts of either of them. In fact, the chances seem good, that he believed both systems to operate concurrently.[7]



Adolf Erik Nordenskjöld

In 1896, Adolf Erik Nordenskjöld, a Stockholm professor of mineralogy and Arctic explorer, published an essay, "About Drilling for Water in Primary Rocks,"[8] which was to win him a nomination for the Nobel Prize in physics, though he died before the prize was actually awarded. Nordenskjöld had spent years on rocky promontories on and islands off the Swedish coast, organizing the drilling of wells for pilotage stations that were forced to import water or capture rain. The impetus for his effort came from his father, Nils, who was Chief of Mining in Finland. He had told his son, with some awe, that while salt water never penetrated iron mines on the Finnish coast, even when they were below sea level, fresh water was always present on the rocky floors of the same mines!

From his work, Nordenskjöld concluded that a new type of water, independent of the hydrologic cycle, and generated by the Earth itself, was available. He called this water "primary," due to its association with so-called "primary rocks," which geologists term *magmatic*, or those, such as granites, basalts, and rhyolites, which derive from the molten magma deep within the Earth and later cool to crystallize into igneous rocks. He also affirmed that one could sink wells capable of producing such "primary water" year-round along the northern and southern coast of the Mediterranean Sea and in the whole of Asia Minor—precisely the best known part of the world afflicted with aridity.

Shortly after the appearance of Nordenskjöld's essay, his speculations about water newly formed in the Earth were echoed by a German geologist, Edward Suess, who coined the term "juvenile" or youthful, to characterize this water. Speaking with special reference to the thermal springs at Carlsbad (now Karolvy Vary in the former Czechoslovakia), he advanced persuasive arguments to show that waters of this class "see the light of day for the first time." That is, they issue from deep within the Earth, from the fundamental magma itself, to bring up veritable additions to the hydrosphere.[9]

Suess' contribution was noted by Frank Wigglesworth Clarke, a geologist with the United States Geological Survey, who, in a long memoir published in 1924, wrote that one of the most important questions for geology was whether it is possible to discriminate between waters of superficial origin and magmatic, or deep-seated, waters,[10] for which I have coined the more descriptive term "Earth-generated" waters.

Clarke cites the work of Armand Gautier, who pointed out several criteria for discriminating between Vadose (water located in the zone of aeration in the Earth's crust) and magmatic waters and who stated that one cubic kilometer of granite, subjected to requisite heat and pressure within the Earth, could yield from twenty-five to thirty million metric tons of water—or something in excess of eight billion gallons—which at 1,100°C would form 160 billion cubic meters of steam. A family of four uses an average of 600 gallons of water per day for their daily sustenance and personal use. Calculated accordingly, such copious supplies of water would be sufficient for the daily need of about 1.25 million households of four.

Courtesy of University of Pennsylvania are Book & Manuscript Library

Geologist
Frank Wigglesworth Clarke
1847 - 1931

The eminent mining geologist, Josiah Edward Spurr, in his two-volume treatise published in 1923, called attention to the fact that the existence of water as an essential component of igneous magmas had long been recognized. The existence was clearly shown

by the vast clouds of water droplets that condense from the emitted vapor during volcanic eruptions.

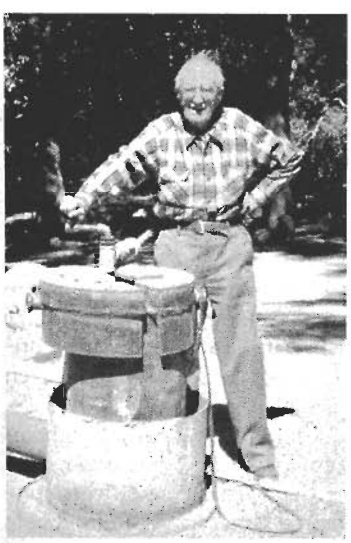
The fundamental idea that there is a thermodynamic cycle within the Earth that both produces and is fueled by water was still of concern at least up to 1942, when Oscar Meinzer, formerly head of the Groundwater Division of the U.S. Geological Survey, in his book *Hydrology* (published in 1942), espoused the view that waters of internal origin are *tangible additions* to the Earth's water supply.

Fifteen years before the publication of his book, Meinzer in a long essay referred to huge springs in the United States that yield 5,000 gallons or more per minute. This phenomenon is not confined to the United States. One incredibly productive water source flowing out of limestone is the Ain Figeh spring that alone supplies water for the over one million residents of Damascus, Syria, and is also the principal source for the Barada River. A report on this spring by the World Bank reads:

> The principal emergence for the spring which has been enclosed in a structure since Roman Times resembles an underground river several meters across which flows up and out of the limestone formation of the mountain. The total flow has averaged about 132,000 gallons per minute. The quality is very good, its temperature and pH are relatively constant (14 degrees centigrade and 7.9, respectively), its taste and color are excellent, and bacterial contamination at the source is practically non-existent.[11]

(The same report is equivocal about the origin of the massive amount of water that has been flowing from this spring for millennia.)

Engineers digging tunnels have also frequently been faced with an outrush of water from what had to be considered an anomalous or mysterious source, given the depth at which it was contacted. Typical was the Tecolote tunnel in the United States, which runs 6.4 miles through the Santa Ynez Mountains to transport water from the Cachuma Reservoir to Santa Barbara, California. In the drilling process, the work was impeded by subterranean water flows of 9,000 gallons per minute, some of which was cool and fresh, some hot and mineralized. What the city of Santa Barbara could have saved by now in water supply expenses by drilling to tap such water (at a cost orders of magnitude less expensive than the 1957 completion price of the tunnel, $40 million) is a matter for conjecture. This issue is at the core of financial considerations in development schemes generally.[12]



Stephan Riess (ca. 1980) at one of his wells drilled at California City, California, in the middle of the Mojave Desert.
Photo by Peter Britton of The Riess Institute

Another anomalous episode, one of the strangest to occur in the annals of construction engineering, took place in Manhattan in 1955. An engineering firm had begun excavating for the addition to the Harlem Hospital at the intersection of 5th Avenue and 136th Street. On St. Valentine's Day, while removing a layer of hard rock only twelve feet below ground, workers were suddenly confronted with an enormous out-pouring of water, which rapidly began to fill the vast excavation. Pumps hurried to the site labored day and night at a rate of 2,000 gallons per minute to keep the working area free of water.

Stephan Riess with 1,900 gallon-a-minute well he drilled above bone-dry Simi Valley, California. *Courtesy of The Riess Institute*

Particularly puzzling to engineers was that during the cold winter months the water maintained a constant temperature of 68°F and was so pure that hospital chemists who analyzed it certified it could be drunk without chlorination or other chemical treatment! A billion and a quarter gallons were pumped out of the hole until twelve stories of structural steel had been erected and several lower floors were decked with concrete slabs, which provided enough weight to hold down the foundation of the new building against hydrostatic pressure from this mysterious water.

Despite the fact that New York City has repeatedly been faced with serious water shortages over the past decades, no effort has been made to utilize the more than three million gallons a day that came out of the granite of Gotham's body near the Harlem Hospital, or to drill for more such sources. Trying to explain this over thirty years ago, Michael Salzman, then a professor at the University of California's School of Commerce, who had served as an engineer with the U.S. Navy's Hydrographic Office, pointedly wrote: "There can be but one reason why this water, despite its purity and constant flow, is not used, and that lies in the many fears associated with it, since its existence cannot be explained by conventional hydrologic practice."

Salzman dedicated his book to Stephan Riess with an inscription, which said:

> To Stephan Riess, for demonstrating his firm belief in democracy, individual initiative, free enterprise, and the need for open minds to the end that all men [humans]

may truly be free to think and solve the great problems of their times.

Riess (1898-1985) was a Bavarian-born mining engineer and geologist who emigrated to the United States in 1923. While working in a deep mine at high elevation in the 1930s, after a load of dynamite had been set off in the bottom of it, Riess was amazed to see water come gushing out in such quantities that pumps installed to remove it at the rate of 25,000 gallons per minute could not make a dent in the flow. Staring forth into the valley below, Riess asked himself how water that supposedly had trickled into the Earth as rain could rise through hard rock into the shafts and tunnels of a mine nearly at the top of a mountain range.

The temperature and purity of the water suggested to Riess it must have a completely different origin than ordinary groundwater. Since none of the textbooks he had studied had referred to what seemed to confront him as an entirely anomalous phenomenon, he decided to look into it further.

In 1957, after Riess had been working on the problem nearly two decades, *Encyclopedia Britannica's Book of the Year* ran the following statement:

> Stephan Riess of California formulated a theory that "new water" which never existed before, is constantly being formed within the earth by the combination of elemental hydrogen and oxygen and that this water finds its way to the surface, and can be located and tapped, to constitute a steady and unfailing new supply.

This is not the place to document the incredible success Riess had over fifty years of practice drilling water wells at sites where professional hydrologists and geologists flatly predicted that not a drop of water could be found.[13] But the central questions that arise are: How far have scientists actually gone to determine the nature and amount of deep-seated, Earth-generated water, and in what way is society capable of accommodating the developments which would inevitably accompany the acceptance of this discovery and paradigm shift?

Earth-generated water pours from a rock face near the Dead Sea in Jerusalem.
Courtesy of The Riess Institute

In his foreword to Salzman's book, the English philosopher and writer Aldous Huxley comments poignantly: "It remains to be seen whether those who are now regarded as experts in the field of hydrology and the politicians whom they advise will also agree that a good case has been made and that large-scale experimentation is in order." Since Huxley penned that sentence more than a quarter century ago, there has been no such experimentation, large or small, funded by hydrologic officials, state or federal, in the United States, or elsewhere in the world. Only private investors and entrepreneurs with foresightful initiative have dared to carry the research forward.

By 1958, Riess' exploits came to the attention of the Israeli government, which invited the mining engineer and geologist for an official visit to find water for the then-new city of Eilat on the Red Sea's Gulf of Aqaba. After a flight to Tel Aviv, he met with Prime Minister David Ben-Gurion and his advisors, who urged him to go ahead with his search as soon as possible. Less enthusiastic were a group of leading Israeli geologists, who, like their American counterparts, vigorously opposed Riess' theory and methodology of water development. "Only after a protracted session during which I explained it," Riess would later relate, "did they agree that my proposal had merit." This was confirmed by Israel's chief water geologist at the time, Arie Issarof, who in a letter, wrote: "As a geologist who is occupied with water research in arid zones, I am fully aware of the limitations of our orthodox methods, in geohydrological possibilities which may be opening up before us while applying these methods. I decided, encouraged by my superiors, to cooperate with Mr. Riess' research for primary waters in our arid zones."

High in the mountainous country along the Israel-Jordan border, Riess located the first of several wells about a mile and a half from Eilat itself. As Meir Ben-Dov wrote in the *Jerusalem Post*:

> The site chosen is where a five-meter-wide cleft, running vertically through the mountain, is crossed at right angles by a similar cleft, hardly twenty centimeters across. The bowels of the earth in erupting have filled these clefts with an igneous intrusion of a sort, soapy-feeling, mottled brown rock called gabbro. The drill slowly worked its way downward, alternately in igneous intrusion and again in granite as the cleft in the rock snaked its way downward.

During the work, problems linked to cave-ins and the jamming of drill pieces beyond the Israeli drilling team's experience were finally solved when Riess' associate, Jim Scott, who had worked with him on many wells over the years, was sent to Israel to supervise operations.

On May 29, 1959, the *Jerusalem Post* published an estimate that the amount of water struck in the Riess-located wells was enough to supply a city of more than 100,000 persons including industry, air-conditioning, parks, gardens, and a dozen outlying villages. Analysis of the water, stated the newspaper, revealed that the Eilatis, used to drinking water with 3,000 parts per million of dissolved mineral salts (TDS), now had a supply with only 1/6 that amount of TDS. For his work in Israel, Ben-Gurion presented Riess with a medal and his wife with a sterling silver-bound copy of the Talmud in English.

The astounding find was not lost on Arab leaders, neighbors of Israel. Invited to Cairo by Egypt's Gamal Abdel Nasser, Riess became the only exception to a rigid years-long stricture prohibiting Americans who had visited Israel from setting foot in Arab lands. Along the Nile, Riess located several water wells on rocky promontories for well-known Egyptians before flying on to the Sudan at the invitation of the Mahdi, where a revolution disrupted his planned geological exploration for water. This prompted his return home.

In fact, Riess' exploits in drilling for fresh water were not quite as unusual as it might have seemed then, because his was perhaps the most recent of a number of accomplishments in this area by others, such as Leo Picard, a contemporary and fellow German who had been born into a Jewish family in 1900 in the city of Wangen near Konstanz, Germany. From 1924 to the present, Picard devoted his life to geology and groundwater exploration in what was then Palestine and is now Israel, following completion of his academic training in geology at the University of Freiburg, Germany. His accomplishments are in addition to and related to those of Riess, ones that we will not have an opportunity to revisit in this short space. Nor is it possible now to delve into the life and work of Fritz Josef Heidecker, another contemporary of Stephan Riess, who was born in 1912 in Georgensgmuend in Mittelfranken, Germany as the third son of an old, established Jewish family, whose documented lineage goes back to 1650. Fritz Josef Heidecker was another builder in the Middle East who devoted much time and energy to building wells during the infancy of the State of Israel.

By analogy, the concept of plate tectonics developed first by the eminent German geologist, Karl Wegener, nearly a century ago, was probably as difficult for geologists to tolerate then as the concept of "Earth-generated water" is for hydrologists now. Few of them are aware that the profession as a whole lags behind the times. In 1960, one of hydrological science's critics, William C. Ackerman (then-vice-president of the American Geophysical Union, AGU, and chief of the Illinois Water Survey Division) tried to shake up his colleagues at a regional meeting at Moscow, Idaho. He expressed his disappointment that for years many revolutionary papers on hydrology submitted to the AGU's *Transactions* had been refused publication. Ackerman concluded that the heart of the problem was that hydrology had been resting for too long on the laurels of its greatest figures, whose work had been performed prior to World War II. He said that nothing of consequence had been contributed to the subject since then.[14]

Water Rights and Water Use in the Middle East

In the ancient Middle East, water was perhaps the single most important factor that influenced the settlement patterns, life, and culture of its inhabitants. Since vast areas of the ancient Middle East were comprised of deserts, settlements and cultures developed for the most part in a region (often referred to as the Fertile Crescent) where fertile soil and a major source of water were located. Thus, we find in the history of antiquity the evolution of villages and towns along the Nile River in Egypt and the Tigris and Euphrates Rivers in ancient Mesopotamia. In Palestine and Syria some communities evolved near rivers, while others originated near springs, such as Jericho—perhaps the oldest known city in that region of the world.

Notwithstanding the location of such water resources throughout the Middle East, the accessibility of water was often a problem. In some areas water resources were present year-round, but the transport of water for irrigation and domestic needs was still difficult. So a variety of water systems developed throughout the ancient Middle East—irrigation systems, storage, and methods to transport water from one locale to another.

You may recognize the following scene: A lone figure dressed all in black, tall and of proud bearing, materializes out of the mirage caused by the blistering heat, where the glare of the dry sky meets the hostile floor of the desert. As he slowly moves forward, his attitude becomes tense, and his eyes blaze with disdain as he reaches the well, where a stranger plunges his head into the water to slake his thirst. He looks up in sudden terror. With a single stroke of his sword, the man in black slashes off the wet head of a man taking more than his due. "He was sullying my well," explains the executioner.

The scene is from the film "Lawrence of Arabia," based on a passing reference in *The Seven Pillars of Wisdom*. Though it is a mythic event, it is a good image for the harsh reality of the desert—a clear warning that water in the arid environment of the Middle East is a matter of life and death. The tableau shows too the uncompromising rigidity of the laws and rules surrounding water that grew out of the customs of the desert. A thirsty man may drink from another man's well, but only in the manner prescribed. He may lower a container, and the water in the container will become his property, without any compensation due; but he must not dive into the water or immerse himself, which would pollute the well.

For centuries, the history of the desert lands of the Middle East centered on the wells and water courses as tribes followed the vegetation with their herds and traders traveled from well to well as they opened up the great caravan routes. In this century, Turks and Arabs—with the occasional involvement (some might call it interference) of British, German, French, and American forces—fought for control of the wells along desert routes to determine the outcome of the First World War in the dry and hostile wastes of the Arabian peninsula.

Eighty years later these old adversaries are still fighting over scarce and rapidly diminishing water resources. But now they have more destructive weapons, thanks to the willingness of external powers to provide them. Everyone wants to secure the riches provided by oil, a resource for which water is key, both in the exploration for oil and in its refining. The cinematic scene at the well demonstrates yet another truth in the Middle East: water cannot be owned. All that can be controlled is the means by which it is transported or distributed. Only in case of disputes does water itself become a strategic commodity, to be

Sinai Peninsula as seen from Space Shuttle Columbia mission STS-4, June 27 - July 4, 1982.

denied to an enemy or even contaminated in a way no desert-dweller would normally consider. At times, a whole civilization can be wiped out by the destruction of an irrigation system, as the Moguls did to the Persians, or the Iraqi government has attempted to do with Marsh Arabs in the lower parts of the Mesopotamian delta in more recent times. In times of peace (or "non-war," for that is the reality in the Middle East today), there are other rules. There is a slowly evolving set of basic criteria to complement the customs that for decades generally succeeded in organizing the sharing of water resources. The map of the Middle East has changed. Tribes acquired flags and national boundaries; customs and rules that were once effective in governing water-sharing between cousins and tribes related by blood no longer work when the cousins have become sovereign nations.

In the West Bank, Israeli military occupation forces are selective in applying Ottoman or Jordanian law, or the new military order, which tends to add to the burden of occupation and deepens the sense of alienation of the local population. Elsewhere, without water-sharing agreements, one state might limit water flow to others, as Turkey did to Syria and Iraq in January 1990. Turkey stopped the flow of the Euphrates to fill the Ataturk Dam, a part of Eastern Anatolia Development Project. At the same time, Cairo received reports that Israel was helping Ethiopia to erect dams on the Blue Nile, threatening to lower Egypt's already low water levels. In both cases, international law and diplomacy took over and the situation was resolved peacefully, but the potential for conflict was there and has not disappeared.

Apart from minimizing the danger of conflict and the potential for the outbreak of war, there is another compelling reason now for trying to codify the use of water resources in the Middle East. Environmental issues, expected to become even more urgent as the area works its way toward a level of peaceful co-existence, demonstrate an urgent need to balance optimum use of water resources with a well-founded understanding and concern for the quality of the environment.

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The most elaborate (even by modern day standards) irrigation systems in the ancient world were developed in Mesopotamia and Egypt. Evidence of more limited and less-elaborate systems have been found in ancient Palestine and elsewhere. The systems of Mesopotamia consisted of a series of canals, cut from rivers like the Tigris and Euphrates, into the fertile regions between the rivers. The feeder canals were then tapped by individuals who used smaller channels to bring water to private plots. The important societal role these systems played in the cultures of ancient Mesopotamia is demonstrated by references to them and information about their construction and maintenance in ancient records, *e.g.* the Mari tablets, as well as inscriptions from Assyrian kings such as Sennacherib and others.

While irrigation systems of Mesopotamia were designed primarily to transport vast amounts of water, the Egyptian systems were constructed to distribute "mud-water" (water with rich deposits of silt) from collecting pools or basins to agricultural plots in the Nile River valley. Irrigation systems were also applied in ancient Palestine, where evidence of sluice gates, channels, and catchment basins designed to capture run-off water from the Jordan River or streams in the Transjordan provide lasting testimony of those practices.

One of the most important sources of water, however, was the natural spring, such as the Gihon spring at Jerusalem and the spring at Jericho. The location of many of Palestine's earliest settlements was determined by springs of this type. Irrigation systems associated with springs have been found at Jericho, where water was diverted to fields or plots, and in Jerusalem where water was channeled from the Gihon spring along the east side of the Ophel ridge to provide water distribution for the Kidron valley.

Wells were constructed in semiarid regions used by pastoral nomads and village herdsmen, as well as in some ancient towns. Since southern Palestine was semiarid, wells such as those located at Beersheba[15] and Gerar[16] constituted the major water supply for herds and flocks. Even in ancient times, the wells were frequently a source of contention between the local herdsmen and the more nomadic pastoral nomads.[17] Large storage units, including reservoirs and pools hewn out of solid bedrock formations below the surface of the ground, were designed to capture the water that came during the rainy season.

Excavations at Ai, Raddana, Qumran, and other locales have uncovered a series of such reservoirs or collecting vats that provided water for the ancient community. Though the water supply depended on rainwater, *i.e.* the hydrologic cycle, it was being channeled through a network of canals or watercourses from the surrounding hills to the collecting pools in the community. Generally, the systems were designed for one of two reasons: 1) to provide safe passage to the water supply; and 2) to bring the water to a more convenient location.

Warren's Shaft, named after Charles Warren who discovered it in Jerusalem in 1867, was designed and engineered by the pre-Israelite inhabitants of Jerusalem, the Jebusites. It was a water system located beneath the surface on the east side of the old city of Jerusalem, also known as the Ophel ridge, just above Gihon spring. It was designed to provide safe access to the spring during times of warfare, and consisted of an entrance on the side of the hill, a tunnel of approximately 130 feet length, a shaft about forty-two feet deep at the lower end of the tunnel, and a horizontal channel which brought water from the Gihon spring back under the ridge to the base of the shaft. This shaft was the means by which David captured the city and made it his capital.[18]

In another instance, two major water systems have been discovered at Gibeon, home of the Gibeonites who served the Israelites as "hewers of wood and drawers of water."[19] The earliest of the systems, perhaps built about the twelfth century B.C., consisted of a large cylindrical pool, approximately 37 feet in diameter and 35 feet deep, carved into solid bedrock. The pool had a spiral staircase which led to a tunnel that descended to a kidney-shaped water room.

Ancient Megiddo had a water system that was constructed in three different stages, with each replacing or improving the earlier. The earliest phase, from prior to the time of Solomon, consisted of a short stepped passage through the city wall that was connected to a covered stairway leading to the spring chamber near the base of the mound. The Solomonic system was replaced by an extremely large system constructed in the ninth century B.C., with steps and a tunnel that led from the base of the shaft of the spring near the base of the mound. At a

later time, the tunnel was deepened in order to allow the water to flow to the base of the vertical shaft. The ancient city of Hazor had a shaft and tunnel system similar to the one at Megiddo; however, the Hazor shaft was approximately twice as large as the Megiddo shaft with steps wide enough that pack animals could be used to carry the water up and out. The shaft-and-tunnel method was also used for the design of the water system at Gezer, which consisted of a rectangular shaft, and a tunnel that led to a large cave filled with spring water.

It is noteworthy that historical sources from antiquity, though filled with examples of different regimes governing the extraction and use of water, are generally silent about instances in which the rules actually denied the ruled access and use of this vital resource. Limited though it may have been, ancient rulers from pre-Solomonic times to the Middle Ages appear to have recognized that a persistent denial of access to and use of water would only invite a state of permanent conflict with the population—anathema to the rule of law and order. Even though water may have been used strategically in times of war to achieve victory, once the conflict was over, the victors typically would return in practice and policy to the sharing of water.

In present times, the apparent lack of clear interpretation of an international or regional legal regime in the water flashpoints of the Middle East will only help to aggravate the already tense situation and perpetuate existing imbalances in the exploitation of water—often based on certain states being militarily and politically dominant powers. Strong downstream countries use their military might to take more than their fair share of available waters, and regularly imply that they might take action that would threaten the stability of upstream countries if they attempted to develop hydrological projects on the shared watercourse. Thus we have Israel against Jordan, Lebanon, Syria, and West Bank Palestinians; Egypt against Ethiopia and Sudan.

Countries not in a position to force a powerful neighbor to reach a fair settlement on the use of water might start a war that would put Western interests at risk, thus requiring intervention. Since they could not win a war single-handedly against the neighbor who threatens their water supplies, they would create an unstable situation leading to a general regional conflict. Weaker states would hope to achieve two aims: 1) to secure allies against a powerful neighbor and 2) to precipitate a war involving the international community, which would lead to water issues being put on the agenda of general settlement. Neither scenario is acceptable, of course, both being fraught with serious danger.

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Mark Twain's witty comment, "Whiskey is for drinkin', water is for fightin'," describes the situation in the Middle East, where fresh-water resources are replacing oil as the probable cause for the next international armed conflict. While Egypt, Ethiopia, Sudan, and Uganda are staking out claims in the Nile River basin, and Iraq, Syria, and Turkey eye one another over the Tigris-Euphrates river system, Lebanon, Jordan, and Syria are competing with Israel over water rights in the Jordan Valley.

The Ottoman Empire used the *sharia* as the basis for its water law in the civil code known as *Al majalla othomaniyah*, in which eighty-two articles deal with water. Those articles became an important source for the codification of Islamic law in the Levant, and they remain the residual legislation for Iraq, Syria, Lebanon, Jordan, and Palestine-Israel.

In the late seventeenth and early eighteenth centuries, there was a transformation of the Levant under Ottoman rule, with the rules of the *sharia* and the body of precedents being codified into legislation that was also affected by the influence of the French colonists. This helped establish a more comprehensive approach to water sharing in the Levant and other countries under both Ottoman and French influence.

The Ottoman *majalla* redrafted the original laws after incorporating the French legislation, and these were still the rules governing water use in places such as Mauritania (1921), Lebanon (1926), and Tunisia and Algeria (as late as the 1970s). Countries that came under the British influence—Turkey, Saudi Arabia, and most Gulf countries, Jordan, Libya, Sudan, and Yemen—had a different approach based on customary usage, *sharia*, and other rules. Egypt, however, was an interesting case: it had been in the heart of the Ottoman Empire, came under strong French influence, and was occupied by the British in 1882. From that time, it was the British who influenced the irrigation, educational systems, and army, right up to 1956. Yet Egypt never implemented the *sharia*, any of the Ottoman laws, or the French Code, but kept the ancient traditional ways related to the Nile. This showed, once again, how the state and the river together make the national identity of that which is Egypt.

As in other parts of the world, population growth is of concern in the Middle East, too, where Israel's population has increased dramatically, and its national average use of water per person per day is at least five times as much as in neighboring countries. Israel is at present using 95% of its available water resources. In 2000 or soon thereafter, it may be short by one-third of its needs, as one million immigrants are awaiting re-settlement from abroad in that troubled country's borders. Since 1948, Israel has multiplied sixfold the acres dependent on irrigation for cultivation. Although Israeli farmers are admittedly among the most water-efficient in the world, the government may soon have to choose between water-intensive crops, such as cotton, and critical domestic and industrial needs.

The questions of a reliable source of water, whether potable or not, are closely connected to the far deeper, implicit questions of what development is, might be, and how it can be implemented. Is it not conceivable and appropriate now to anchor a lasting peace in the troubled Middle East in a Regional Water Authority with cross-boundary jurisdiction? It could be created collaboratively, staffed, financed, and operated cooperatively by all the nations in that region, friend and foe alike, who depend on this life-giving resource?

The legal, technical, and political issues surrounding water and its many-faceted uses transcend a human lifetime. They are certainly not confined neatly to national boundaries, and are perhaps among the great problems of our times. Perhaps the paradigm of "Earth-generated water," given increased attention and application, will lead to enduring solutions.

For now, let us bring our journey to a close with a quote from Aharon David Gordon (1856-1922), a pioneer in Galilee, whom Arthur Koestler quotes in his book *Diebe in der Nacht* (*Thieves in the Night*; 1983). Gordon:

> We shall shake off the old life, which has become rancid

for us and shall begin anew. We do not want any changes or modifications and we do not want any improvements. We simply want to begin anew.

References

1. Exodus 14:21. 1967. *The New Scofield Reference Bible*, 88.
2. *Ibid.*, Song 4:15, p. 708 and Rev. 7:17, p. 1359.
3. For instance, "Water Warning Being Prepared by City Officials," *New York Times*, January 15, 1983; and "Tucson Streets are in Trouble, but Without Water It Won't Matter," *Washington Post*, November 23, 1982.
4. Grundy, Denise. 1982. "Trouble in Atlantic City," *Discover*, March.
5. "Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan," Committee on Sustainable Water Supplies for the Middle East, National Academy of Sciences, Washington, DC, 1999; see also, Summer 1982 issue of *California* magazine (cover story).
6. *Ibid.*
7. Biswas, Asit K. *History of Hydrology*, North Holland Publishing.
8. Nordenskjöld, Adolf E. "Om Borningar Efter Vatten in Uberget."
9. Suess, Edward. 1902. "Ueber Heisse Quellen," Leipzig, *Gesellschaft deutscher Naturforscher und Aerzte Vehandlung*, translated in part by D. H. Newland, *Engineering and Mining Journal*, 1903, p. 76, July 11.
10. Clarke, Frank Wigglesworth. 1924. *The Data of Geochemistry*, U.S. Geological Society, Bulletin 770, Washington, DC.
11. For a photo of this spring see Bird, Christopher. 1979. *The Divining Hand*, E.P. Dutton, 153.
12. Salzman, Michael. 1960. *New Water for a Thirsty World*, Science Foundation Press, Los Angeles, CA.
13. For a more detailed treatment of the work of Stephan Riess see Bird, Christopher, *The Devining Hand*, E.P. Dutton, Chapters 8 and 9.
14. Ackerman, William C. 1961. "Needed: Three Wise Men," *Transactions*, American Geophysical Union, **42**, 1, March.
15. *Ibid.*, *The New Scofield Reference Bible*, Genesis 21:30, p. 31.
16 *Ibid.*, Genesis 26:18, p. 39.
17. *Ibid.*, Genesis 21:25, p. 31; Genesis 26:15, p. 38-39; and Genesis 26:19-22, p. 39.
18. *Ibid.*, 2 Sam 5:6-10, p. 363.
19. *Ibid.*, Josh 9:23, p. 269.

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Albert Einstein: Assessing His Life and Science An *Infinite Energy* Special Issue

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